Collective excitations in correlated two-dimensional fermion systems

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Godfrin *et al.* performed a neutron scattering experiment on two-dimensional (2D) ^{3}He.[1] They found the zero sound mode at small wave-vectors; the mode was found to lie very close to the particle-hole (PH) continuum band. At intermediate wave-vectors, the mode entered the PH band and was broadened by the Landau damping. Interestingly, they found that the mode reappeared below the PH band at large wave-vectors. To understand these findings, it is necessary to consider the correlation effect beyond the RPA theory as was emphasized, e.g. in Ref. 2. In this paper, we study the dynamical responses of 2D fermion systems taking account of the correlation effect.

We use a model on a 2D lattice as an effective model for liquid ^{3}He. To suppress the lattice discretization effect, we consider the dilute limit, $n \simeq 0.1$, where n is the fermion number density. In addition to the on-site repulsion, we consider the interaction between particles at different sites. We thus study the dynamical responses of a dilute 2D extended Hubbard model. The correlation effect is considered with the second-order perturbation theory; the self-energy and the vertex corrections are consistently considered. In addition to the density correlation function, we calculate the spin correlation function.

[1] H. Godfrin *et al.*, J. Low Temp. Phys. **158**, 147-154 (2010).
[2] H. M. Bohm *et al.*, J. Low Temp. Phys. **158**, 194-200(2010).